The SNO LED Data Analyses

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SNO uses a pulsed laser source to calibrate the relative timing of each PMT to ensure that timing variations are adequately compensated to ensure the best possible event reconstruction. This time correction is critical for all SNO data analyses; thus, it is desirable to have additional independent optical sources to provide a cross check. Six LEDs deployed by LBNL SNO group provided such an opportunity. The LEDs were installed in fixed frame of the PMT support structure and their locations were accurately determined through engineering calculations.

LED data taken during the air fill was used in the analysis. Without water in the detector, photons traversing through the air-acrylic boundaries were much more likely to get refracted. In order to determine the hit time of photons travelling in straight lines, we carefully chose the prompt peak in the time distribution for every PMT. Figure 1 shows the light-path-corrected hit time vs. distance plot. There is a jump in the band around $distance \approx 1200cm$ because in order to hit PMTs further away than this distance, photons have to pass through the AV. Because the speed of light in acrylic is smaller than that in air, photons passing through the AV arrive later than ones missing the AV.

We carried out the analysis in two steps [1]:

1. We used the hit times calibrated by the laser data to reconstruct LED positions. The reconstructed positions did not agree with the nominal positions.

2. We used a LED to directly calibrate the PMT timing. The laser position was then reconstructed. The reconstructed laser position did not agree with its nominal position.

3. Because of their locations and the angular distribution of the emitted light, each LED can illuminate only a few hundred PMTs. We extended the analysis by using PMTs overlapped by the light from two LEDs to adjust the difference in the LED source times. Six LEDs were divided into 3 pairs, and reconstruction using tubes calibrated by 3 pairs of LEDs consistently indicated there was a $\sim$ 20cm vertical offset between the reconstructed and nominal laserball.

We concluded that the laser ball position used in PMT timing calibration may not be correct. This error in position may be caused by misalignment of the AV and the PSUP as the location of the laser was referenced to the AV while locations of the LEDs and PMTs were referenced to the PSUP.

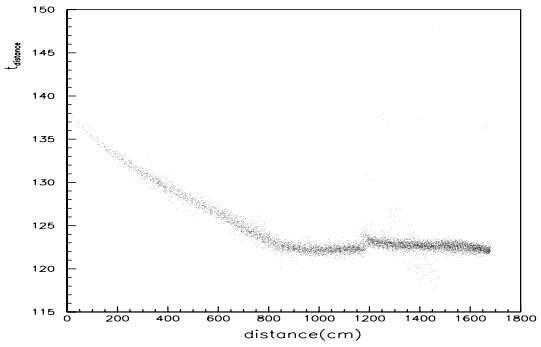

Figure 1: Distance corrected time vs. distance (between the LED and PMT) plot for all PMTs illuminated by the LED. Every entry in the plot corresponds to a PMT. $t_{distance} = t_{pmt} - distance/v_{light}$.

References

[1] X.Chen; LED Data analysis in Air Fill, SNO-STR-99-008, 4/2/1999.